NOTES

DATE:

SEPTEMBER HOLIDAY REVISION

SEC 3 PURE CHEMISTRY

Instructions:
Please complete your Mock Exam Paper under timed conditions and bring it for class.

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4.2 The Mole Concept and Stoichiometry

relative atomic mass, A_r
average mass of an atom of an element compared to $\frac{1}{12}$ the mass of one carbon-12 atom
relative molecular mass, M_r
average mass of a molecule of a substance (element/compound) compared to $\frac{1}{12}$ the mass of one carbon-12 atom
relative formula mass, M_r
average mass of a unit of an ionic compound compared to $\frac{1}{12}$ the mass of one carbon-12 atom
molar mass
mass of one mole of a substance - numerical value is equivalent to the relative mass of the substance - unit: g/mol

Formulae

one mole of any substance contains 6.02×10^{23} particles (**Avogadro's constant**) no. of particles = **no. of moles** $\times 6.02 \times 10^{23}$		**no. of moles** $= \frac{\text{mass (in g)}}{\text{molar mass}/M_r}$
molar volume of gas 1 mole of any gas = 24 dm^3 at r.t.p.	molar concentration $= \frac{\text{no. of moles}}{\text{volume}}$ mol/dm^3	mass concentration $= \frac{\text{mass}}{\text{volume}}$ in g/dm^3
percentage yield $= \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\ \%$	percentage purity $= \frac{\text{mass of pure substance}}{\text{mass of sample}} \times 100\ \%$	percentage by mass of an element in a compound $= \frac{A_r \times \text{no. of atoms}}{M_r \text{ of compound}} \times 100\ \%$

Calculating percentage by mass of an element in a compound

calcium carbonate: $CaCO_3$ M_r of $CaCO_3 = 40 + 12 + 3\times16 = 100$ ⇨ molar mass of $CaCO_3$ = 100 g/mol 50 g of $CaCO_3$ contains: 20 g of Ca, 6 g of C, 24 g of O percentage by mass of Ca: $\frac{20}{50} \times 100\ \% = 40\ \%$ C: $\frac{6}{50} \times 100\ \% = 12\ \%$ O: $\frac{24}{50} \times 100\ \% = 48\ \%$	percentage by mass of Ca: $\frac{40}{100} \times 100\ \% = 40\ \%$ C: $\frac{12}{100} \times 100\ \% = 12\ \%$ O: $\frac{3\times16}{100} \times 100\ \% = 48\ \%$

Limiting and excess reagents

- The limiting reactant is the substance that is completely used up.
- It **determines the yield of the reaction**, which is the amount of product that forms.

Stoichiometry for gas

Volume ratio of gases = mole ratio of gases in a chemical equation

🗋 Exercise

$Al_2(CO_3)_3(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2O(l) + 3CO_2(g)$

- ___ mole of $Al_2(CO_3)_3$ reacts with ___ moles of sulfuric acid to produce ___ moles of CO_2.

1. Complete reaction (theoretical)

234 g of $Al_2(CO_3)_3$ reacts completely with ____ dm^3 of 1 mol/dm^3 H_2SO_4 to produce ____ g of CO_2.

- The volume of CO_2 produced is ____ dm^3.

2. Excess and limiting reactants

Excess $Al_2(CO_3)_3$ was added to 25 cm^3 of 1 mol/dm^3 H_2SO_4.

- Only _____ moles of $Al_2(CO_3)_3$ react. ≡ _____ g of $Al_2(CO_3)_3$
- _____ moles of CO_2 will be produced. ≡ _____ dm^3 of CO_2 ≡ _____ g of CO_2

3.00 g $Al_2(CO_3)_3$ was added to 50 cm^3 of 1 mol/dm^3 sulfuric acid.

- _____ moles of $Al_2(CO_3)_3$ and _____ moles of H_2SO_4 are available.
  - ⇨ _____ moles of $Al_2(CO_3)_3$ will react completely with _____ moles of H_2SO_4.
  - ⇨ Since _____ moles of sulfuric acid is available, it is the _____ reagent.
- _____ is the limiting reagent.
- no. of moles of $Al_2(SO_4)_3$ produced = _____ mol
- no. of moles of H_2O produced = _____ mol
- no. of moles of CO_2 produced = _____ mol ≡ _____ cm^3 of CO_2 ≡ _____ g of CO_2

3. Calculating percentage purity of sample

A 300 g sample containing impure $Al_2(CO_3)_3$ was added to 25 cm^3 of 1 mol/dm^3 H_2SO_4 to produce 72 dm^3 of CO_2.

- Mass of pure $Al_2(CO_3)_3$ present = _____ g
- The percentage purity of the sample is _____ %.

4. Calculating percentage yield of a reaction

234 g $Al_2(CO_3)_3$ was reacted with excess sulfuric acid to produce 120 g of CO_2.

- If reaction was 100 % complete, ____ g of CO_2 will be produced.
- The percentage yield of the reaction is _____ %.

🗋 Exercise

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
• _____ mole of N_2 reacts with _____ moles of H_2 to produce _____ moles of NH_3.
1. Complete reaction (theoretical)
28 g of N_2 reacts completely with _____ g of H_2 to produce _____ g of NH_3. ○ The volume of NH_3 produced is _____ dm^3.
_____ cm^3 of N_2 reacts completely with 90 cm^3 of H_2 to produce _____ cm^3 of NH_3.
2. Excess and limiting reactants
14 of N_2 and 6 g of H_2 are mixed. ○ _____ mol of N_2 and _____ mol of H_2 are available. ⇨ 3 mol of H_2 will react completely with _____ mol of N_2. ○ Since 0.5 mol of N_2 is available, it is the _____ reagent. ○ _____ mol of NH_3 will be produced ≡ _____ dm^3 of NH_3 ≡ _____ g of NH_3

Types of formulae	examples	
	ethyl ethanoate $CH_3COOCH_2CH_3$	**oxalic acid** $(COOH)_2$
empirical formula		
shows the simplest ratio of the constituent elements in a compound		
molecular formula		
shows the actual number of atoms of the constituent elements in a compound		

🗋 Deriving empirical and molecular formulae

/ Answer template:

	$element_1$	$element_2$	…
(percentage by) mass			
A_r/molar mass			
no. of moles			
mol ratio			

Let the molecular formula of the compound be $(empirical\ formula)_n$.

$n \times M_r$ of empirical formula = M_r of compound

n = _____

ionic compound	H_2O
1	x

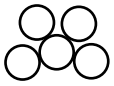
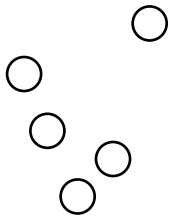
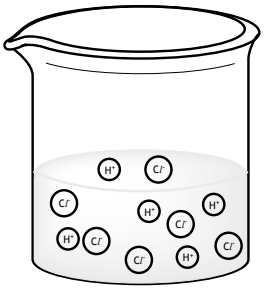
Finding moles of water of crystallisation in hydrated crystals

e.g. $CuSO_4.5H_2O$, $FeSO_4.7H_2O$

🗋 Comparing acids of different basicity (same concentration and volume)

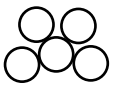
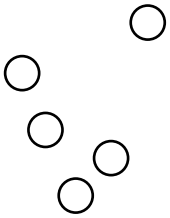
HC*l* Particles: HC*l* molecules; H^+ Cl^- ions

Molar mass of HC*l* = _____ **g/mol**

	 **liquid**	 **gas**	 **aqueous solution**
no. of moles	5 mol		
mass	_____ g		250 g
no. of particles present	_____ HC*l* molecules		
	_____ H atoms _____ C*l* atoms		_____ H^+ ions _____ Cl^- ions
volume		_____ dm^3	250 cm^3
molar concentration			_____ mol/dm^3
mass concentration			_____ g/dm^3

H_2SO_4 Particles: H_2SO_4 molecules, H^+ SO_4^{2-} ions

Molar mass of H_2SO_4 = _____ **g/mol**

	 **liquid**	 **gas**	 **aqueous solution**
no. of moles	5 mol		
mass	_____ g		250 g
no. of particles	_____ H_2SO_4 molecules		
	_____ H atoms _____ S atoms _____ O atoms		_____ H^+ ions _____ SO_4^{2-} ions
volume		_____ dm^3	250 cm^3
molar concentration			_____ mol/dm^3
mass concentration			_____ g/dm^3

5.1 Acids and Bases

Acid	
a substance that ionises in water to produce **H^+ ions**	
basicity	maximum number of H^+ ions formed per acid molecule
strength	extent of dissociation of the acid molecule in water ○ 100 %: strong ○ < 100%: weak

Examples	
strong monobasic - hydrochloric acid, $HCl \rightarrow H^+ + Cl^-$ - nitric acid, $HNO_3 \rightarrow H^+ + NO_3^-$	**strong dibasic** - sulfuric acid, $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$
weak monobasic - ethanoic acid, $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$	**weak dibasic** - carbonic acid, $H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$

Base
a substance which reacts with an acid to form a salt and water only • metal oxides, metal hydroxides
Alkali
a soluble base which dissociates in water to produce **OH^- ions**
strength — extent of dissociation of the alkali in water ○ 100 %: strong ○ < 100%: weak
Examples
strong sodium hydroxide, $NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$ potassium hydroxide, $KOH(aq) \rightarrow K^+(aq) + OH^-(aq)$
weak aqueous ammonia, $NH_3\ (g) + H_2O\ (l) \rightleftharpoons NH_4^+\ (aq) + OH^-\ (aq)$

🗋 **Scenario: acidic soil contains a high concentration of H^+ ions that may be unsuitable for plants to thrive**	
(1) fertilisers contain _____ ions to provide the _____ element necessary for plant growth	(2) calcium hydroxide can be used to _____ acidic soil to control the pH for optimum plant growth
What happens: (2) removes the _____ ions in the acidic soil via _____. It also reacts with (1), causing ammonia to form according to the following chemical equation: _____ This remove the _____ content in the soil which plants cannot absorb for their growth.	

Chemical Reactions Involving Acids and Bases

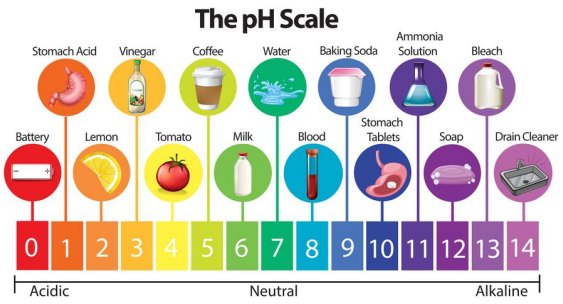
Chemical equation	acid + metal → salt + hydrogen gas
Ionic equation	*spectator ion: anion from acid
Observations	• effervescence of a colourless and odourless gas (main observation) • temperature of mixture increases • metal decreases in size (if in excess) or completely reacts in the acid (if a soluble salt is formed)
Test for gas	Place a lighted splint into a test tube containing the gas. The lighted splint extinguishes with a 'pop' sound.
Note!	• not suitable for unreactive metals, e.g. _____ • reaction of lead metal with HC*l* and H_2SO_4 results in formation of ppt as well

Chemical equation	acid + carbonate → salt + carbon dioxide + water
Ionic equation	*spectator ion: anion from acid
Observations	• effervescence of a colourless and odourless gas (main observation) • carbonate decreases in size (if in excess) or completely reacts in the acid (if a soluble salt is formed)
Test for gas	Bubble the gas through aqueous calcium hydroxide (limewater). A white precipitate forms in limewater.

Chemical equation	acid + insoluble base → salt + water
Ionic equation	*spectator ion: anion from acid
Observations	• base decreases in size (if in excess) or completely reacts in the acid (if a soluble salt is formed) • temperature of mixture increases
Chemical equation	acid + alkali → salt + water
Ionic equation	*spectator ion: cation from alkali, anion from acid
Observations	• temperature of mixture increases
Note!	• acid + aqueous ammonia →_____

Chemical equation	alkali + ammonium salt → salt + water + ammonia
Ionic equation	
Observations	• a colourless and pungent gas is evolved upon warming mixture
Test for gas	Place a damp red litmus paper near the gas. The damp red litmus paper turns blue.

pH

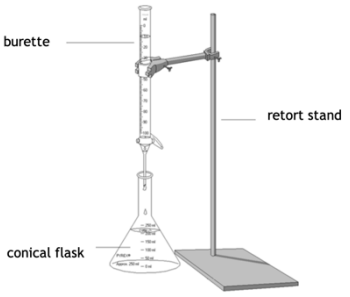


$pH = -\log_{10}[H^+]$
$[H^+]$ is the concentration of H^+ ions

pH	$[H^+]$
0	1 mol/dm^3
1	0.1 mol/dm^3
2	0.01 mol/dm^3
7	0.0000001 mol/dm^3

acidic	neutral	alkaline
$[H^+] > [OH^-]$	$[H^+] = [OH^-]$	$[H^+] < [OH^-]$

Titration

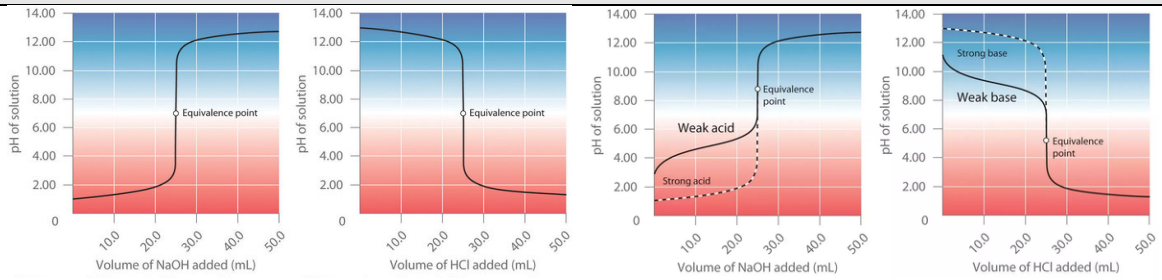


- involves the exact addition of one solution to another for complete reaction
  - acid-alkali, acid-carbonate
  - redox

pH curve

A pH curve may be obtained using a pH meter and a data logger

/ Based on the pH curve, the following may be inferred:
- ☐ the nature (acidic/alkaline) of the solutions in the burette and conical flask
- ☐ the strength of the acid/alkali (refer to initial or final pH, or equivalence point)
- ☐ volume of solution required for complete neutralisation



Equivalence point for neutralisation reactions

Titration	pH at equivalence point
strong acid – strong base	pH 7
strong acid – weak base	below pH 7 (Usually around pH 5)
weak acid – strong base	above pH 7 (Usually around pH 9)
weak acid – weak base	inconclusive

Types of oxides

basic	amphoteric	acidic	neutral
most metal oxides e.g. Na_2O, MgO, Fe_2O_3	_____	most non-metal oxides e.g. NO_2, SO_2, CO_2, SiO_2	_____
reacts with acids	reacts with acids and alkalis	react with alkalis	no reaction with acids and alkalis

5.2 Salts

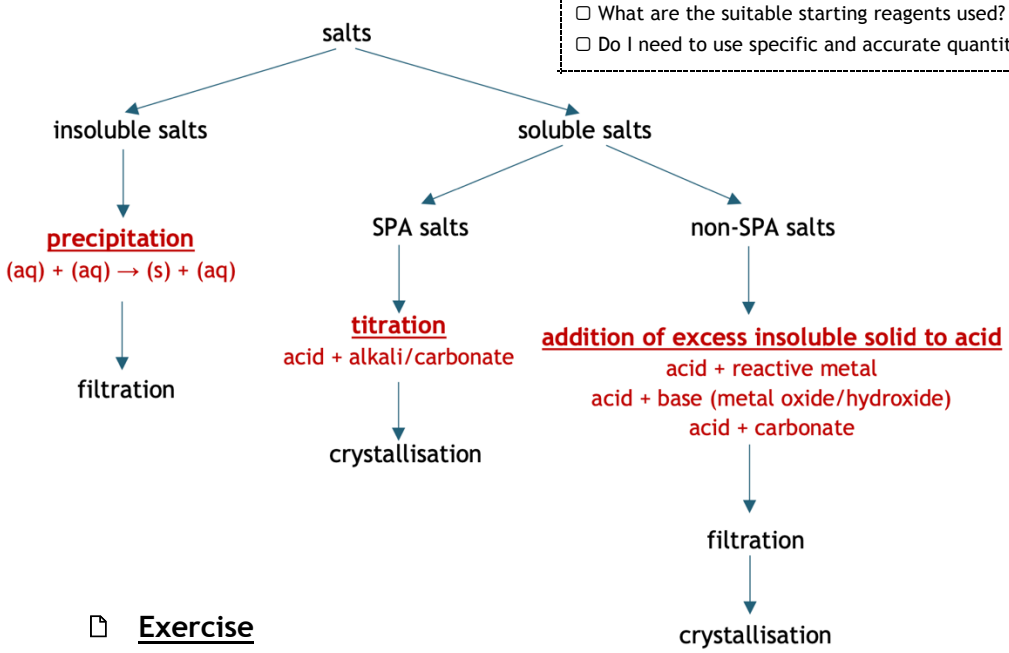
Solubility Table

ionic compounds	soluble in water	insoluble in water
group 1, ammonium "SPA" Sodium-Potassium-Ammonium	ALL	none
nitrate	ALL	none
chlorides, iodides	ALL except	lead(II) chloride, $PbCl_2$ silver chloride, $AgCl$ lead(II) iodide, PbI_2 silver iodide, AgI
sulfates	ALL except	barium sulfate, $BaSO_4$ calcium sulfate, $CaSO_4$ lead(II) sulfate, $PbSO_4$
carbonates	SPA salts	ALL except

Methods of Salt Preparation

/ Thinking process:

- ☐ Is the salt soluble in water?
- ☐ What method of preparation should be executed?
- ☐ What are the suitable starting reagents used?
- ☐ Do I need to use specific and accurate quantities (volume, mass) of the reagents?



🗋 Exercise

salt	reactant 1	reactant 2	method
lead(II) chloride			
	HCl	KOH	
zinc nitrate			

Exercise

6. Qualitative Analysis

Test for metal cations (Zn^{2+}, Al^{3+}, Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+})

Addition of NaOH(aq) dropwise until in excess

observation	ppt soluble in excess NaOH	ppt insoluble in excess NaOH
white ppt formed	$Zn(OH)_2$, $Al(OH)_3$ colourless solution formed	$Ca(OH)_2$
coloured ppt formed	–	_____ $Cu(OH)_2$, _____ $Fe(OH)_2$, _____ $Fe(OH)_3$

Addition of NH_3(aq) dropwise until in excess

observation	ppt soluble in excess NH_3	ppt insoluble in excess NH_3
white ppt formed	$Zn(OH)_2$ colourless solution formed	$Al(OH)_3$
coloured ppt formed	_____ $Cu(OH)_2$ _____ solution formed	_____ $Fe(OH)_2$, _____ $Fe(OH)_3$
no observable change for Ca^{2+}	–	–

Test for ammonium ion

Add aqueous sodium hydroxide and warm the mixture.

observation	A colourless and pungent gas forms, causing damp red litmus paper to turn blue.

Test for anions

test		observation	anion present
add dilute nitric acid		Effervescence of colourless and odourless gas observed. When gas was bubbled through limewater, a white ppt ($CaCO_3$) is produced.	CO_3^{2-}
	followed by $Ba(NO_3)_2$	**white** ppt ($BaSO_4$)	SO_4^{2-}
	followed by $AgNO_3$	**white** ppt ($AgCl$)	Cl^-
		yellow ppt (AgI)	I^-
Add dilute NaOH(aq), followed by aluminium foil and warm the mixture. $NO_3^-(aq) \rightarrow NH_4^+(aq) \rightarrow NH_3(g)$		A colourless and pungent gas was evolved, causing damp red litmus paper to turn blue.	NO_3^-

Test for gases:

gas	colour, smell	test	observation
CO_2	colourless, odourless	limewater	white ppt
NH_3	colourless, pungent	damp red litmus paper	turns blue
Cl_2	greenish-yellow, pungent	damp blue litmus paper	turns red first then gets bleached
H_2	colourless, odourless	lighted splint	extinguishes with a 'pop' sound
O_2	colourless, odourless	glowing splint	relights /rekindles
SO_2	colourless, pungent	acidified $KMnO_4$ OR acidified $K_2Cr_2O_7$	purple to colourless OR orange to green

🗋 **Note:**

1. litmus paper must be damp to test for gases
2. SO_2 is a reducing agent which reacts with oxidising agents

END OF YEAR MOCK EXAMINATION
SECONDARY THREE
BASED ON 2024 SEAB SYLLABUS

CHEMISTRY **6092/01**

Paper 1 September 2024

30 minutes

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **twenty** questions on this paper. Answer **all** questions. For each question, there are four possible answers A, B, C and D.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Optical Answer Sheet.

Fill in the Optical Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question paper.
The use of an approved scientific calculator is expected, where appropriate.

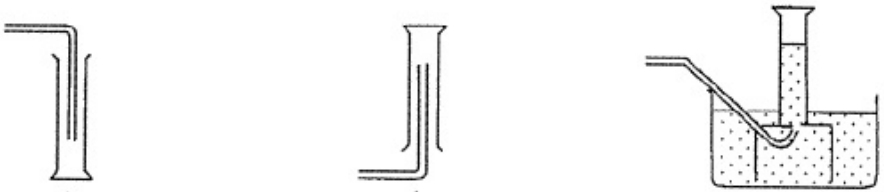
Shade the corresponding lozenge.

Total score: _____

1	A ▭	B ▭	C ▭	D ▭
2	A ▭	B ▭	C ▭	D ▭
3	A ▭	B ▭	C ▭	D ▭
4	A ▭	B ▭	C ▭	D ▭
5	A ▭	B ▭	C ▭	D ▭
6	A ▭	B ▭	C ▭	D ▭
7	A ▭	B ▭	C ▭	D ▭
8	A ▭	B ▭	C ▭	D ▭
9	A ▭	B ▭	C ▭	D ▭
10	A ▭	B ▭	C ▭	D ▭
11	A ▭	B ▭	C ▭	D ▭
12	A ▭	B ▭	C ▭	D ▭
13	A ▭	B ▭	C ▭	D ▭
14	A ▭	B ▭	C ▭	D ▭
15	A ▭	B ▭	C ▭	D ▭
16	A ▭	B ▭	C ▭	D ▭
17	A ▭	B ▭	C ▭	D ▭
18	A ▭	B ▭	C ▭	D ▭
19	A ▭	B ▭	C ▭	D ▭
20	A ▭	B ▭	C ▭	D ▭

Question 1

The diagrams below show three methods of collecting gases.



1 2 3

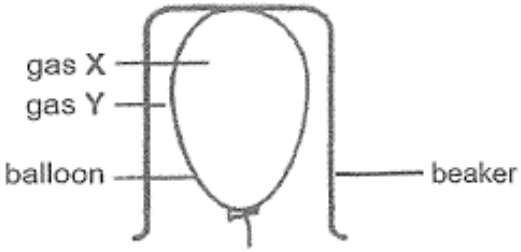
Hydrogen gas has low solubility in water.

Which method(s) is / are suitable for collecting hydrogen gas?

(A) 1 only
(B) 2 only
(C) 1 and 3 only
(D) 2 and 3 only

Question 2

A balloon filled with gas **X** is placed inside a beaker that is filled with gas **Y**.



What pair of gases would cause the balloon to shrink a few hours later?

	gas X	**gas Y**
(A)	ammonia	nitrogen
(B)	argon	ammonia
(C)	carbon dioxide	oxygen
(D)	nitrogen	carbon monoxide

Question 3

Which statement best explains why sodium chloride has a lower melting point than magnesium oxide?

(A) Sodium is more reactive than magnesium.

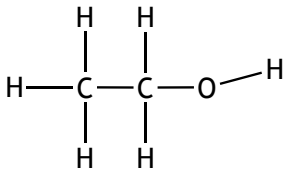
(B) Sodium chloride is covalent but magnesium oxide is ionic.

(C) The molar mass of magnesium oxide is lower than sodium chloride.

(D) The electrostatic forces of attraction are weaker in sodium chloride than in magnesium oxide.

Question 4

Ethanol has the structure shown.



How many valence electrons in a molecule of ethanol, C_2H_5OH, are **not** involved in bonding?

(A) 0 (B) 2

(C) 4 (D) 8

Question 5

Which particles are responsible for the conduction of electricity through an ionic compound in its aqueous or molten state?

(A) electrons only

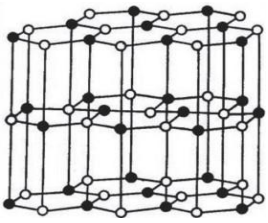
(B) anions and cations

(C) cations and electrons

(D) cations, anions and electrons

Question 6

Which of the following best explains the reason why the substance with the structure shown below would be a good lubricant?



(A) weak covalent bonds between the layers of atoms

(B) strong covalent bonds between the layers of atoms

(C) weak forces of attraction between the layers of atoms

(D) weak electrostatic forces of attraction between the layers of atoms

Question 7

Hydrogen reacts with oxygen according to the following equation.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

What is the total volume of gas left in the mixture when 30 cm^3 of hydrogen reacts with 30 cm^3 of oxygen? (All volumes are measured at room temperature and pressure.)

(A) 15 cm^3 (B) 30 cm^3

(C) 45 cm^3 (D) 60 cm^3

Question 8

An impure sample of 1.00 g of silver oxide reacts with excess nitric acid to form silver nitrate and water. The reaction produces 0.86 g of silver nitrate.

$$Ag_2O + 2HNO_3 \rightarrow 2AgNO_3 + H_2O$$

What is the percentage purity of the impure sample?

(A) 31.3 % (B) 58.7 %

(C) 85.5 % (D) 86.0 %

Question 9

Melamine is a plastic containing 28.6 % carbon, 4.8 % hydrogen and 66.6 % nitrogen by mass.

If the relative molecular mass of melamine is 126, what is its molecular formula?

(A) CH_2N_2

(B) $C_2H_4N_4$

(C) $C_3H_6N_6$

(D) $C_4H_8N_8$

Question 10

250 cm^3 of 3.00 mol/dm^3 dilute hydrochloric acid is added to 350 cm^3 of 2.00 mol/dm^3 dilute hydrochloric acid.

What is the concentration of the resulting solution?

(A) 1.46 mol/dm^3

(B) 2.42 mol/dm^3

(C) 2.50 mol/dm^3

(D) 8.33 mol/dm^3

Question 11

Which statement about the same concentration and volume of ethanoic acid and hydrochloric acid is correct?

(A) Ethanoic acid has a lower pH than hydrochloric acid.

(B) Both ethanoic acid and hydrochloric acid are strong monobasic acids.

(C) Hydrochloric acid is a strong monobasic acid, while ethanoic acid is a weak monobasic acid.

(D) Both ethanoic acid and hydrochloric acid give the same colour when tested with Universal Indicator.

Question 12

Which statement does not describe a property of aqueous ammonia?

(A) It forms a salt with sodium hydroxide.

(B) It has a pH of between 8 and 9.

(C) It reacts with sulfuric acid to form salt and water.

(D) It reacts with copper(II) sulfate to form a blue precipitate.

Question 13

Which salt should **not** be prepared by reacting a dilute acid with excess metal?

(A) iron(II) sulfate
(B) lead(II) chloride
(C) magnesium sulfate
(D) zinc nitrate

Question 14

Which salt is not prepared by titration?

(A) ammonium nitrate
(B) magnesium nitrate
(C) potassium sulfate
(D) sodium sulfate

Question 15

Which reagent could be used to distinguish between dilute hydrochloric acid and dilute nitric acid?

(A) aqueous silver nitrate
(B) aqueous sodium hydroxide
(C) magnesium oxide
(D) zinc carbonate

Question 16

A student carried out a series of tests on an aqueous solution of sodium carbonate and recorded his observations.

Which test should be repeated because of an incorrect observation recorded?

	test	**observation**
(A)	add aqueous ammonia solution	no visible reaction
(B)	add barium chloride solution	no visible reaction
(C)	add copper(II) chloride solution	blue precipitate formed
(D)	add dilute hydrochloric acid	effervescence is observed

Question 17

J is an aqueous solution.

On addition of aqueous sodium hydroxide to **J**, a green precipitate is formed. The resulting mixture is heated and no gas is formed.

Aluminium foil is added to the warmed mixture. A gas is formed that turns damp red litmus paper blue.

Which ions could be present in **J**?

(A) Fe^{2+} and NH_4^+

(B) Fe^{3+} and NH_4^+

(C) Fe^{2+} and NO_3^-

(D) Fe^{3+} and NO_3^-

Question 18

In which pair does the underlined element have the same oxidation state in its compounds?

(A) $Cu\underline{Cl}_2$ and $Na\underline{Cl}$

(B) $H_2\underline{S}$ and $\underline{S}O_2$

(C) $\underline{Fe}_2O_3$ and $\underline{Fe}SO_4$

(D) $H_2\underline{O}_2$ and $H_2\underline{O}$

Question 19

Which is the oxidising agent in the reaction between iron and nitric acid?

$$Fe(s) + 2HNO_3(aq) \rightarrow Fe(NO_3)_2(aq) + H_2(g)$$

(A) H^+

(B) Fe

(C) Fe^{2+}

(D) NO_3^-

Question 20

Which pair of compounds shows that transition elements have variable oxidation states?

(A) Cr_2O_3 and $CrBr_3$

(B) $CuSO_4$ and $CuCl_2$

(C) Fe_2O_3 and $FeCl_2$

(D) NiO and $NiCl_2$

END OF YEAR MOCK EXAMINATION
SECONDARY THREE
BASED ON 2024 SEAB SYLLABUS

CHEMISTRY **6092/02**

Paper 2 September 2024

40 minutes

READ THESE INSTRUCTIONS FIRST

Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.

The use of an approved scientific calculator is expected, where appropriate.

SCORE

Paper 1		20
Paper 2		30
TOTAL		50

Question 1

The chemical formulae of eight substances are shown below.

H_2	$MgSO_4$	NaC*l*	CO
$AgNO_3$	CH_4	ZnO	Pb

Answer the following questions using the chemical formulae of the substances given above.

(a) Which substance has both covalent and ionic bonds? [1]

(b) Which substance can conduct electricity in its solid state? [1]

(c) (i) Which two substances form a white precipitate when their solutions are mixed with one another? [1]

(ii) Construct an ionic equation for your answer in (c)(i). [1]

[Total: 4]

Question 2

(a) Sodium chloride has a high melting point.

(i) Draw a 'dot-and-cross' diagram to show the electronic structure of sodium chloride. You only need to show the outer shell electrons. [1]

(ii) Use your knowledge of bonding in sodium chloride and chlorine gas to explain the difference in their melting points. [2]

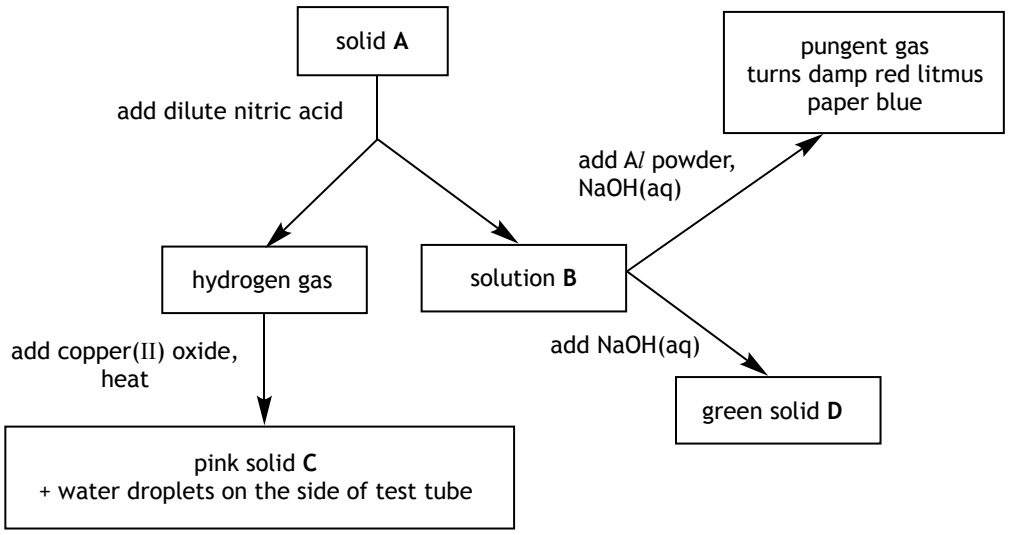
(b) Describe a simple experiment which you could carry out to determine whether an aqueous solution contained an ionic or covalent compound.

Your answer should clearly state all the equipment required and how the observations made would lead to the conclusion. [3]

[Total: 6]

Question 3

The flowchart shows the observation of some reactions with solid **A**.



(a) Identify **A**, **B**, **C** and **D**. [4]

A _____

B _____

C _____

D _____

(b) Write an ionic equation, with state symbols, for the reaction between solid A and dilute nitric acid. [2]

_____

(c) State the colour change in **D** when it was left to stand. [1]

_____

[Total: 7]

Question 4

The table shows the colours of manganese in different oxidation state.

substance	colour	oxidation state of manganese
Mn	silver	0
MnO_4^-	purple	
Mn^{2+}	light pink	+2
MnO_4^{2-}	green	
MnO_2	brown	+4

(a) Complete the table above by filling in the oxidation state of manganese for MnO_4^- and MnO_4^{2-}. [2]

(b) When manganese(II) nitrate is heated, it decomposes to form manganese(IV) oxide and an acidic gas only.

(i) Write a balanced chemical equation for the decomposition of manganese(II) nitrate. [1]

(ii) Describe the colour change of manganese(II) nitrate during the reaction. [1]

[Total: 4]

Question 5

The reaction between nitrogen and hydrogen to form ammonia is shown below.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) 3 tonnes of hydrogen were reacted in the reaction to produce 2 tonnes of ammonia. Calculate the percentage yield. [2]
(1 tonne = 1 000 000 g)

(b) Ammonia dissolves in water to form aqueous ammonia, which is a weak alkali.

(i) Write the dissociation equation, with state symbols, for aqueous ammonia. [1]

(ii) Based on your answer in (b)(i), explain whether aqueous ammonia conducts electricity. [1]

(c) Aqueous ammonia reacts with sulfuric acid to form ammonium sulfate.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

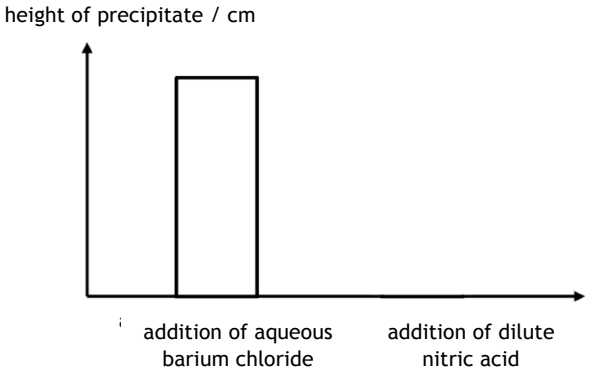
Calculate the percentage by mass of nitrogen in ammonium sulfate. [2]

(d) A water supply is suspected to be contaminated with ammonium sulfate or ammonium carbonate.

To identify the anion present, the student performed the following tests:

1. Add aqueous barium chloride to a test tube containing the sample of water.
2. Measure the height of the precipitate formed after 5 minutes.
3. Add excess dilute nitric acid to the above mixture.
4. Measure the height of the precipitate formed after 5 minutes.

The results were obtained in a graph as seen below.



(i) Based on the results, give the chemical formula of the anion present in the water supply. [1]

_____

(ii) Explain your answer in d(i) with reference to the information provided. [2]

_____

_____

_____

_____

_____

[Total: 9]

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Jurong East	Sunday	4PM - 6PM

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Bukit Timah	Wednesday	7.30PM-9.30PM
Bukit Timah	Saturday	5PM-7PM